DIVISION 16
ELECTRICAL

SECTION 16010

ELECTRICAL GENERAL REQUIREMENTS

PART 1: GENERAL

1.1 SCOPE:

a. Applicable requirements of the General Conditions of the Contract, Amendments, Supplementary General Conditions, and Special Conditions govern work under this Division.

b. Work covered by this Division consists of providing all labor, equipment, supplies, and materials; and performing all operations, including trenching, backfilling, cutting, patching, and chasing necessary for the installation of complete electrical systems in strict accordance with these specifications and the applicable drawings.

c. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

d. This Contractor is referred to the General and Special Conditions of the contract which shall form a part and be included in this section of the specification and shall be binding on this Contractor.

e. Some items of equipment are specified in the singular; however, the Contractor shall provide and install the number of items or equipment as indicated on the drawings, and as required for complete systems.

1.2 DEFINITION:

a. The word "Contractor" as used in this section of the specification refers to the Electrical Contractor unless specifically noted otherwise. The word "provide" means furnish, fabricated, complete, install, erect, including labor and incidental materials necessary to complete in place and ready for operation or use the item referred to or described herein and/or referred to on the Contract Drawings.

1.3 CONTRACTOR'S QUALIFICATIONS:

a. It is assumed that the Contractor has had sufficient general knowledge and experience to anticipate the needs of a construction of this nature. The Contractor shall furnish all items required to complete the construction in accordance with reasonable interpretation of the intent of the Drawings and Specifications. Any minor items required by code, law or regulations shall be provided even if not specified or specifically shown, where it is part of a major system.

1.4 CONTRACT DOCUMENTS:

a. The contract drawings are diagrammatic and are not intended to indicate every detail of construction, or every item of material or equipment required, or exact locations. Indicated locations of outlets, equipment, and connections are approximate and shall be verified by reference to related

documents.

b. The Contractor shall procure complete drawings and specifications on all coincident construction and fit the Electrical work in with it. He shall cooperate with other trades to achieve well coordinated progress and final result; and avoid conflicts with other trades. He shall make minor moves and changes necessary to accommodate other equipment and/or preserve symmetry without claim for extra payment. Should there be any doubt as to the spacing intent, or location of equipment, the Contractor shall have the point clarified by the Architect/Engineer before proceeding with the installation.

1.5 RECORD DRAWINGS:

a. During construction of this project, the Contractor shall maintain one complete set of electrical contract drawings, on which shall be recorded all significant changes. This set of drawings shall be used for no other purpose. Upon completion of the work, the Contractor shall submit these drawings to the Architect/Engineer for approval and presentation to the Owner.

1.6 REGULATIONS AND COMPLIANCE:

a. The requirements of the North Carolina State Building Code which includes the National Electrical Code, and of all other State and Local codes, ordinances, regulations and interpretations by authorities having jurisdiction are binding upon this Contractor, and nothing contained in, or inferred by, these specifications or the applicable drawings may be construed as waiving those requirements. The latest edition of the National Electrical Code, referred to herein and on the drawings as "N.E.C.", forms a part of these specifications; and under no circumstances may the installation fail to meet the minimum requirements therein.

b. This Contractor shall secure and pay for all permits, fees, inspections and licenses required. Upon completion of the project and prior to his request for final payment he shall present to the Architect/Engineer a certificate of inspection and approval from the inspection authorities.

c. The Contractor shall include in his work, without extra cost to the Owner, any labor, materials, service, apparatus, drawings, in order to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on drawings and/or specified.

d. All materials furnished and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, and with the requirements of all governmental departments having jurisdiction.

e. All materials and equipment shall bear the approval label, and shall be listed by the Underwriters' Laboratories, Inc.

f. It is the responsibility of the contractor to notify the local electrical inspector to schedule the required inspections.

1.7 ELECTRICAL TESTING:

a. Conduct full scale tests with all lights, equipment and appliances in operation and prove the electrical system satisfactory for operation and free

from defects. Pay particular attention to the balancing of the single-phase loads on the three-phase system. Promptly remedy all defects.

b. All current phase conductors and neutrals shall be tested as installed, and before connections are made, for insulation resistance, continuity and accidental grounds. This shall be done with a 500 volt megger. The procedures listed below shall be followed:

1. Minimum readings shall be one million or more ohms for #6 AWG wire and smaller, 250,000 ohms or more for #4 AWG wire or larger, between conductors and between conductor and the grounding conductor.

2. After all fixtures, devices and equipment are installed and all connections completed to each panel, the contractor shall disconnect the neutral feeder conductor from the neutral bar and take a megger reading between the neutral bar and the grounded enclosure. If this reading is less than 250,000 ohms, the contractor shall disconnect the branch circuit neutral wires from this neutral bar. He shall then test each one separately to the panel and until the low reading is found. The contractor shall correct troubles, reconnect and retest until at least 250,000 ohms from the neutral bar to the grounded panel can be achieved with only the neutral feeder disconnected.

3. At final inspection, the contractor shall furnish a megger and show that the panels comply with the above requirements. He shall also furnish a hook-on type ammeter and voltmeter to take current and voltage readings as directed.

c. Upon completion of installation of the electrical grounding and bonding systems, the ground resistance shall be tested with a ground resistance tester. Where tests show resistance-to-ground is over 25 ohms, appropriate action should be taken to reduce the resistance to 25 ohms, or less, by driving additioan ground rods. (The compliance should be demonstrated by retesting).

d. All tests specified shall be completely documented indicating time of day, date, temperature and all pertinent test information.

e. All required documentation of readings indicated above shall be submitted to Engineer prior to, and as one of the prerequisites for, final acceptance of the project.

1.8 GUARANTEE:

a. The Contractor shall guarantee that the work done has been done in accordance with the Contract Documents, free of imperfect materials and defective workmanship. For a period of one year after acceptance by the Owner, the Contractor shall repair or replace, at no additional expense to the Owner, any imperfect materials or defective workmanship.

1.9 OPERATING AND MAINTENANCE INSTRUCTIONS:

a. At the completion of the project, submit 3 sets of complete operating and maintenance instructions.

b. Organize material in the following format:

1. Section I:

   (a) Name of Project
   (b) Address
   (c) Owner's Name
   (d) Electrical Contractor's Name and Address
   (e) Warranty Dates

2. Section II:

   (a) Description of System

3. Section III:

   (a) Major Equipment List (name, manufacturer)
   (b) Routine Maintenance Instructions in Step-by-Step form

4. Section IV:

   (a) Operating and Maintenance Instructions by Manufacturer
   (b) Shop Drawings
   (c) Wiring Diagrams
   (d) Warranty Information

PART 2: PRODUCTS

2.1 GENERAL:

a. Except where reuse of existing items are specifically indicated or permitted, all materials and equipment shall be new and shall conform to the standards of the National Electrical Manufacturer's Association and Underwriter's Laboratories, Inc. in every instance where such a standard has been established for the item involved.

b. Catalog numbers and trade names in these specifications and drawings are intended only to set forth and convey to bidders the general style, type, character and quality of product desired. Similar products of other manufacturers; of equal quality, size, capacity, character, and appearance may be substituted on the written approval of the Architect/Engineer. Requests for approval of substitutions shall be made after the award of the contract in accordance with the bidding requirements of these specifications.

c. It is the intent of the drawings and specifications that the installation be complete, of finished appearance, and ready for operation. Manufacturers' catalog numbers as used herein and on the drawings are indicative of the type of product to be installed, and do not necessarily identify all parts and accessories required for the proper assembly, installation, and utilization of the product. All required parts and accessories shall be provided.

d. Materials shall be inspected by the Contractor upon their arrival at the site to be sure they are correct. Material and equipment stored on the site shall be protected against physical damage, dirt and damage caused by precipitation, wind, condensation, excessive humidity, and extremes of temperature. Materials shall be stored in their original cartons within

substantial, clean and dry storage facilities provided under this Contract. Conduit, large galvanized boxes, and lighting poles may be stored outdoors on suitable blocks or racks clear of the earth and undergrowth, and pitched to drain. Large electrical equipment intended for ultimate installation outdoors may be stored in the weather on suitable blocks or platforms clear of the earth and undergrowth, and with interior lamps or space heaters continuously energized to prevent condensation. Alternate storage provisions may be submitted to the Architect/Engineer for approval prior to the arrival of the material. Under no circumstances shall equipment be stored in the weather under a cover of polyethylene or tarpaulin. The Architect/Engineer will be the sole judge as to the acceptability of storage facilities, and when directed by the Architect/Engineer, improperly stored or damaged material shall be removed from the site and replaced with new material.

2.2 SUBMITTALS:

a. Within 30 days after the date of award of contract, submit a complete list, in quadruplicate, of materials proposed for installation including requests for approval of substitutions and names of specialty sub-contractors to the Architect/Engineer for approval. Upon approval of the list, the Architect/Engineer will indicate those items for which submittal of shop drawings, cuts, descriptive literature and/or samples are required; and these items will not be considered to be approved until such supplementary data is approved. Any items which fail to comply with specification requirements will be rejected. Intent to use exact material specified does not relieve the Contractor of responsibility for submitting a list. The mention of several manufacturers for any item will not be acceptable.

b. Prior to delivery of any material to the job site, and sufficiently in advance of requirements to allow the Architect ample time for checking, submit for approval detailed, dimensioned drawings or cuts, showing construction, size, arrangement, operating clearances, performance, characteristics and capacity. Each item of equipment proposed shall be standard catalog product of an established manufacturer and of equal quality, finish, performance, and durability to that specified.

c. Submittal of shop drawings, cuts, and descriptive literature shall be made in sufficient quantity to permit the retention by the Architect/Engineer of two copies. Submittal data will not be checked prior to the Approval of the Contractor's material list. In addition to the submittal data requested by the Architect/Engineer, the Contractor may, at his option, submit additional shop drawings and/or descriptive data for approval, provided the manufacturer of the additional items has previously been listed on the Contractor's approved Material List.

d. Submittal data shall be thoroughly reviewed and approved by the Contractor prior to being forwarded to the Architect/Engineer. Submittal data received from the Contractor will be considered to have been reviewed and approved by the Contractor as suitable for the application and for installation in the space allotted.

e. The submittal of shop drawings shall be with the Contractor stamp affixed. This stamp indicates that the Contractor, by approving and submitting shop drawings, represents that he has determined and verified all field measurements and quantities, field construction criteria, material, catalog

material, and similar data that he has reviewed and coordinated information in the shop drawings with the requirements of the work and the Contract Documents. It, also, indicates that any deviation from the Contract Documents has been shown on the submittal and clearly defines the deviations from the specifications.

f. Approval rendered on shop drawings shall not be considered as a guarantee of quantities, measurements, or building conditions. Where drawings are approved, said approval does not mean that drawings have been checked in detail. Said approval does not in any way relieve the Contractor from his responsibilities or necessity of furnishing material or performing work as required by the contract drawings and specifications.

g. Failure of the Contractor to submit shop drawings in ample time for checking shall not entitle him to an extension of Contract time, and no claim for extension by reason of default will be allowed.

h. All shop drawings and submittals are to be in the office of the Architect within 30 days after the Contracts have been awarded. Contractor shall be financially responsible for any price increase of shop drawing items from the time these drawings are issued until they are returned to the Contractor for purchase of items.

i. Contractor shall keep on the job at all times copies of all approved shop drawings.

2.3 EQUIPMENT DEVIATIONS:

a. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawings, which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical, or architectural layout, all such redesign, and all new drawings and detailing required therefore, shall be prepared by the Contractor at his own expense and submitted for approval by the Architect/Engineer.

b. Where such approved deviation requires a different quantity and arrangement of wiring, conduit, and equipment from that specified or indicated on the drawings, the Contractor shall furnish and install any such structural supports, electrical wiring and conduit, and any other additional equipment required by the system, at no additional cost to the Owner.

PART 3: EXECUTION

3.1 GENERAL:

a. The Contractor shall coordinate the work and equipment of this Division with the work and equipment specified elsewhere in order to assure a complete and satisfactory installation. Work such as excavation, backfill, concrete, flashing, wiring, etc., which is required by the work of this section shall be performed in accordance with the requirements of the applicable section of the specifications.

b. It is the intention of these specifications and drawings to call for finished work, tested and ready for operation. Whenever the work "provide" is used, it shall mean "furnish and install complete and ready for use".

3.2 DUTIES OF CONTRACTOR:

a. Contractor shall furnish and install all materials called for in these Specifications and accompanying drawings, and must furnish the apparatus complete in every respect. Anything called for in the specifications and not shown on the drawings or shown on the drawings and not called for in the specifications, must be furnished by the Contractor.

b. Contractor is responsible for familiarizing himself with the details of the construction of the building. Work under these specifications installed improperly or which requires changing due to improper reading or interpretation of building plans shall be corrected and changed as directed by the Architect/Engineer without additional cost to the Owner.

c. The Contractor shall follow drawings in laying out work and check drawings or other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions at all points. Where headroom or space conditions appear inadequate, Architect/Engineer shall be notified before proceeding with installation.

d. While every effort has been made to accommodate the equipment necessary for the work of this contract, it is the responsibility of the Contractor to ensure that equipment supplied as a part of this contract will fit in the spaces provided for by the drawings. Any concern by the contractor regarding the adequacy of a space for the equipment supplied, shall be brought to the attention of the Architect/Engineer in a written form prior to the approval of the related equipment submittals and prior to any rough-in associated with this equipment.

e. The plans are diagrammatic and are not intended to show each and every fitting or a complete detail of all the work to be done; but are for the purpose of illustrating the type of system, etc., and special conditions considered necessary for the experienced mechanic to take off his materials and lay out his work. This Contractor shall be responsible for taking such measurements as may be necessary at the job and adapting his work to local conditions.

f. Conditions sometimes occur which require certain changes in drawings and specifications. In the event that such changes in drawing and specifications are necessary, the same are to be made by the Contractor without expense to the Owner, providing such changes do not require furnishing more materials, or performing more labor than the true intent of the drawings and specifications demands. It is understood that while the drawings are to be followed as closely as circumstances will permit, the Contractor is held responsible for the installation of the system according to the true intent and meaning of the drawings. Anything not entirely clear in the drawings and specification will be fully explained if application is made to the Architect/Engineer. Should, however, conditions arise where in the judgment of the Contractor certain changes will be advisable, the Contractor will communicate with the Architect/Engineer and secure his approval of these changes before going ahead with the work.

g. The right to make any responsible change in location of apparatus, equipment, routing of conduit up to the time of roughing in, is reserved by the

Architect without involving any additional expense to the Owner.

h. It shall be the duty of prospective Contractors to visit the job site and familiarize themselves with job conditions. No extras will be allowed because of additional work necessitated by, or changes in plans required because of evident job conditions, that are not indicated on the drawings.

i. Contractor shall leave the premises in a clean and orderly manner upon completion of the work, and shall remove from the premises all debris that has accumulated during the progress of the work.

3.3 COORDINATION:

a. This Contractor shall coordinate the work of all subs and shall furnish any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.

b. Where the work will be installed in close proximity to, or may interfere with the work of other trades, the Contractor shall assist in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than 3/8" = 1'-0", clearly showing how his work is to be installed in relation to the work of other trades. If the Contractor installs his work before coordination, or so as to cause any interference with work of any subs, he shall make the necessary changes in his work to correct the condition without extra charge.

c. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

3.4 SLEEVES, CUTTING, AND PATCHING:

a. Contractor shall place his own sleeves and advise other trades of required chases and openings so they can be properly built in. Sleeves provided under this division shall be formed out of no less than schedule 40 galvanized rigid steel conduits. Where any raceway supports installed under this Contract pierce the roof, suitable pitch pockets shall be provided and coordinated with the roofing contractor as necessary to be acceptable to the Architect/Engineer. Provide suitable fittings where any raceways or equipment cross expansion joints.

b. Permitted cutting or patching necessary shall be done by Contractor. Structural members shall not be cut except by written permission of Architect/Engineer.

3.5 PROTECTION AND CLEAN-UP:

a. Protect all material and work from damage during construction. Equipment installed in the building prior to its being closed in and dried out shall be protected from the elements in the same manner as previously specified for stored materials. Protect finished surfaces from splattering of mortar, paint, dirt, plaster, etc. Do not install device plates, face plates, canopies, flush cabinet trims, or fixtures on walls or ceilings until after painting or cleaning of the surface has been completed, and arrange for such items that are

required to be field painted to be painted before being mounted. Repair, clean and touch-up or replace all damaged material. At the completion of the project, remove all dust from finished surfaces, including lighting fixtures, lenses and lamps.

b. The Contractor shall keep premises free of debris resulting from his work.

3.6 PAINTING AND FINISHING:

a. Suitable finishes shall be provided on all items of electrical equipment and materials which are exposed. This shall consist of either an acceptable finish as manufactured and supplied to the job or application of suitable finishes after installation.

b. Where installed in finished areas, exposed equipment and materials shall be supplied with prime coat, and shall be professionally painted or enameled as directed to match or blend with adjacent surfaces.

c. In unfinished areas such as equipment rooms, exposed equipment shall be furnished with suitable factory applied finishes (e.g. standard gray enamel finish for panelboards, etc.).

d. Equipment furnished in finishes such as stainless steel and brushed aluminum shall not be painted.

e. All finishing shall be as directed by, and shall be satisfactory to, the Architect/Engineer.

f. Paint material shall be selected from the products listed below and, insofar as practical, products of only one manufacturer shall be used. Contractor shall submit to the Architect/Engineer the listed manufacturer he proposes to use in the work. Should the Contractor desire to use products of a manufacturer not listed below, or products made by a listed manufacturer but not scheduled herein, Contractor shall submit complete technical information on the proposed products to the Architect/Engineer for approval. Only products approved by the Architect/Engineer shall be used.

1. Rust Inhibitive Primer:

(a) Devoe: Bar-Ox Quick Dry Metal Primer, Red.
(b) Duron: Deluxe Red Primer.
(c) Glidden: Rustmaster Tank and Structure Primer.
(d) Pittsburgh: Inhibitive Red Primer.

2. Galvanized Metal Primer:

(a) Devoe: Mirrolac Galvanized Metal Primer.
(b) Duron: Duron Deluxe Galvanized Metal Primer.
(c) Glidden: Rustmaster Galvanized Iron Metal Primer.
(d) Pittsburgh: Speedhigh Galvanized Steel Primer.

3.7 OBSERVATION:

a. The project will be observed periodically as construction progresses.

The Contractor will be responsible for notifying the Architect/Engineer at least 72 hours in advance when any work to be covered up is ready for inspection. No work shall be covered up until after observation has been completed.

SECTION 16030

EQUIPMENT CONNECTIONS AND COORDINATION

PART 1: GENERAL

1.1 SCOPE:

a. The connection of all equipment provided under any Division of these specifications or by the owner requiring electrical connection shall be provided as part of this Division, unless otherwise indicated or specified. Special outlets, where indicated, are considered to be electrical connection to the equipment.

b. Drawings indicate approximate equipment capacity (including motor horsepower) and approximate location of connection. It is the responsibility of this Contractor to determine the exact characteristics of equipment actually being supplied; and to provide proper branch circuit connections, conductor protection, and grounding.

PART 2: EXECUTION:

2.1 GENERAL:

a. Heating, Ventilating, Air Conditioning, Refrigeration and Plumbing Equipment: Unless otherwise indicated, provide all power wiring, including feeders and branch circuits, to the terminals of the equipment, including mounting of motor starters; feeder and branch circuit over-current protection; disconnecting means within sight of each motor and each starter, whether or not specifically indicated on drawings.

b. Individually mounted motor starters: Unless otherwise indicated, individually mounted motor starters will be furnished as part of the Division furnishing the driven equipment. Unless otherwise indicated, remote control wiring for Heating, Ventilating, Air Conditioning, and Plumbing equipment will be provided as part of those respective Divisions.

SECTION 16100

BASIC MATERIALS AND METHODS

PART 1: GENERAL

1.1 WIRING METHODS:

a. Unless otherwise indicated or specified, the Wiring Method for this project shall consist of copper conductors with 600 volt insulation installed in metal raceways.

b. The word "Raceway" and the word "Conduit" (or abbreviation "C") used herein or on the drawings indicate Rigid Metal Conduit, and where permitted, Intermediate Metal Conduit, Electrical Metallic Tubing, Rigid Nonmetallic Conduit, Flexible Metal Conduit, or Liquid-tight Flexible Metal Conduit.

c. Reference to "Rigid Conduit" or "RMC" indicates heavy-wall Rigid Metal Conduit only.

d. Reference to "IMC" indicates Intermediate Metal Conduit.

e. Reference to "PVC" indicates Rigid Nonmetallic Conduit.

f. Reference to "EMT" or "Tubing" indicates Electrical Metallic Tubing.

g. Reference to "Flex" or "Flexible Conduit" indicates Flexible Metal Conduit, or, where required, Liquid-tight Flexible Metal Conduit.

h. Other wiring methods, such as Metal-Clad Cable shall be provided to the extent indicated on the drawings and/or hereinafter specified.

1.2 FASTENING METHODS:

a. Acceptable fastening methods include wood screws and nails on wood construction, toggle bolts on hollow masonry, expansion bolts and lead anchors on brick and concrete, and machine screws on metal surfaces.

b. Explosive fasteners may be used in steel and concrete in accordance with the manufacturer's recommendations.

c. Wire, perforated metal strap, and wooden plugs are not acceptable as fastening material.

d. Materials used shall be good quality, made of zinc or cadmium coated steel or other non-corroding material.

e. Materials, whether exposed or concealed, shall be firmly and adequately held in place. Fastening and support shall afford safety factor of three or higher, and shall be in full compliance with the seismic protection requirements of the N.C. State Building Code.

f. Fixtures, raceways, and equipment shall be supported from the structure. Nothing may be supported on suspended ceiling unless definitely

noted so on the Drawings or specifically permitted by the Architect/Engineer.

g. Equipment and raceways attached to outside walls, or interior walls subject to permanent moisture, shall be shimmed out with non-corrodible material so as to provide 1/4" air space between wall and equipment or raceway.

1.3 EQUIPMENT IDENTIFICATION:

a. Suitable nameplates shall be provided for the identification of electrical equipment including Panelboards, Motor Starters, Safety Switches, and Circuit Breakers.

b. Nameplates shall be of engraved white core plastic laminate, not less than 1/16" thick. For 120/208 volt systems, nameplates shall have white letters on blue backgrounds.

c. Engraving shall be of professional quality, with block style letters, minimum 1/4" high.

d. Nameplates shall be attached with sheet metal screws. They shall be sized to allow for installation of screws without obscuring text.

e. All empty conduit runs and conduit with conductors for future use shall be identified for use and shall indicate where they terminate. Identification shall be by tags with string or wire attached to conduit or outlet.

1.4 SLEEVES AND PENETRATIONS:

a. The Electrical Contractor shall provide sleeves and openings for his penetrations through exterior walls, interior walls and partitions, floors, and roofs. Provisions for all such penetrations shall be as approved by the Architect/Engineer.

b. For any raceway passing through an exterior wall, above or below grade, provide appropriate sleeve and water proofing. Center the conduit in the sleeve and fill the space between conduit and sleeve with appropriate compound such as lead and oakum, and then apply caulking compound - Thiocaulk or approved equal - flush with the wall surfaces.

c. For raceways penetrating floor slabs, smoke partitions, and fire-rated walls, provide steel pipe sleeves and seal with high-temperature non-shrink grout or other material as approved by the Architect/Engineer. Materials and installation methods shall be UL listed as a Through-Penetration Firestop System suitable for use with the UL Fire Resistance Design encountered. Refer to the UL fire protection details shown on the drawings. Refer to the UL fire penetration details shown on the drawings.

d. Conduits penetrating roof surfaces for purpose of connecting to roof-top mechanical equipment shall utilize openings and curbs provided for the equipment where possible.

e. For other raceway penetrations through the roof the Contractor shall provide appropriate prefabricated roof curb assemblies - "Pipe Portal System"

as manufactured by Roof Products and System Corp., Addison, Illinois or equal method as approved by Architect/Engineer and Roofing Subcontractor.

SECTION 16110

RACEWAYS AND FITTINGS

PART 1: GENERAL

1.1 SCOPE:

a. Provide complete raceway systems as indicated on the drawings, as herein specified, and as required by applicable codes. Comply with Section 16100 Basic Materials and Methods.

b. All wiring shall be installed in raceways unless specifically noted otherwise.

1.2 SUBMITTALS:

a. Submit for approval manufacturer's data sheets for all raceway system components.

PART 2: PRODUCTS

2.1 MANUFACTURERS:

a. Metal raceway and components shall be as manufactured by Allied, Triangle, Wheatland, Thomas & Betts, or other approved manufacturers.

b. Non-metallic raceway system components shall be as manufactured by Carlon, Queen City Plastics, Ipex, or other approved manufacturers.

2.2 MATERIALS AND APPLICATIONS:

a. Rigid Metal Conduit shall be zinc coated Schedule 40 steel or alloy 6063-T42 aluminum with threaded couplings and fittings. Termination at sheet metal enclosures shall consist of double locknuts and insulating bushings. Rigid Steel conduit shall be used for all exposed and concealed work except where other raceways are indicated or permitted. Aluminum conduit complete with aluminum fittings may be used in lieu of steel conduit except in wet locations, underground, or in poured concrete. Steel and aluminum shall not be mixed in the same run of conduit.

b. Intermediate Metal Conduit (IMC) with threaded couplings and fittings may be used for exposed and concealed work in lieu of rigid metal conduit except underground outside the building foundation, or where supporting lighting fixtures, or in hazardous locations, or where exposed to severe impact or injury. Termination at sheet metal enclosures shall consist of double locknuts and insulating bushings.

c. Electrical Metallic Tubing (EMT) of 2" maximum size may be used for concealed work in lieu of Rigid Metal Conduit except underground or in poured concrete. EMT of 2" maximum size may be used for exposed work in lieu of Rigid Metal Conduit except outdoors, or above a roof, or where supporting lighting fixtures, or where exposed to severe impact or injury, or in hazardous locations, or less than 10 feet above a floor or platform in other than in

electrical, mechanical, or communications closets or equipment rooms.

d. Rigid PVC Conduit shall be Schedule 40, UL listed for use with 90°C. Conduit run underground or run in or under a poured concrete slab shall be rigid PVC. Vertical elbows and vertical extensions from underground or concrete embedded PVC conduits smaller than 3" trade size may also be of PVC provided that they remain concealed or otherwise protected, but shall be of Rigid Steel Conduit (or IMC where permitted) where they stub up into exposed locations or trade size is 3" or larger. An insulating bushing or end bell shall be provided at each termination. Conduit run underground and not under a poured concrete slab shall have installed continuously above it a warning tape. Tape shall be 12 inches wide, centered on conduit and located 12 inches below finished grade.

e. Flexible Metal Conduit shall be of zinc coated steel of minimum length, and shall be used in lieu of Rigid Metal Conduit for connections to moving or vibrating apparatus, recessed lighting fixtures, dry-type transformers, and motors. Flexible Metal Conduit may be used where rigid connections are impractical due to obstructions or space limitations. Flexible Metal Conduit used in wet, damp, or corrosive location shall be PVC jacketed liquid-tight complete with liquid-tight connectors.

f. Fittings for steel conduit and tubing shall be of zinc coated steel or malleable iron. Insulating bushings of plastic provided for Rigid and Intermediate Metal Conduits shall be rated for 150°C. Bonding bushings shall be steel or malleable iron with non-removable plastic throats rated 150°C. EMT fittings shall be of the compression type and concrete tight or rain tight as applicable. Set-screw, indentor, pressure cast, and die cast fittings are not acceptable. Connectors for EMT, Flexible Metal Conduit and Liquid-tight Flexible Metal Conduit shall be the insulated throat type. Connectors for Flexible Metal Conduits shall be of the "Tite-Bite" design.

g. Conduit expansion fittings shall be of zinc coated cast or malleable iron and steel conduit, complete with flexible bonding straps. Expansion fittings shall allow longitudinal conduit movement of 4 inches.

h. Minimum raceway size shall be 1/2". Other raceway sizes, unless indicated on the drawings, shall be determined by the Contractor in accordance with NEC requirements for type THW insulated conductors, or the actual insulation used if it is thicker than type THW.

PART 3: EXECUTION

3.1 INSTALLATION:

a. Rigid and Intermediate Metal Conduits shall be made up with full threads, to which a conductive pipe compound (T & B Kopr-Shield or equal) has been applied, and butted in coupling. Terminations at sheet metal enclosures in indoor dry locations shall be made with double locknuts and an insulating bushing. Terminations at sheet metal enclosures in outdoor, damp, and wet locations shall be made with threaded conduit hubs of zinc coated malleable iron.

b. Except where run under a concrete slab on grade, underground conduits shall be installed a minimum of 30" below grade. Trenching and backfilling

shall comply with Section 16010 Electrical General Requirements.

c. All underground conduits shall have metalized warning tape installed above the conduit that identifies the specific system buried below. The warning tape shall consist of a minimum 3.5 mil solid foil core encased in a protective plastic jacket (total thickness 5.5 mils). Tape shall be 6 inches wide with black lettering imprinted on a color coded background that conforms to APWA color code specifications. Tape shall be installed 18 inches above the conduit and in no case less than 6 inches below grade.

d. Installation of PVC conduit shall be in accordance with the manufacturer's recommendations using solvent welded couplings and fittings. Field bends shall be made with approved heating equipment. Open flames are not permitted. An insulating bushing or end-bell shall be provided at each termination.

e. Conduits shall be rigidly supported not more than 8 feet on center and shall be concealed within walls, ceilings, and floors, except as indicated or specifically approved by the Architect/Engineer; kept at least 6" from flues and steam or hot water pipes; and protected against the entry of dirt, plaster, or trash. Raceways shall be supported independently of suspended ceiling members and suspension wires.

f. Suspended EMT shall be provided with additional hangers at elbows and bends, and where necessary to avoid strain at couplings and connectors.

g. Exposed conduits, where permitted, shall be run parallel or perpendicular to walls, structural members and ceilings; with right-angle turns consisting of symmetrical bends or cast metal fittings with threaded hubs. Offsets may be used where necessary provided that they are of minimum length.

h. Conduits crossing expansion and contraction joints shall cross perpendicular to the joint and shall be provided with expansion fittings. Conduits shall not be embedded in the concrete slabs at the expansion and contraction joints.

i. Immediately after installation, conduit openings shall be covered to prevent entrance of foreign matters. Covers shall remain in place throughout the rough-in stage.

SECTION 16120

CONDUCTORS

PART 1: GENERAL

1.1 SCOPE:

a. Furnish and install a complete system of wire and cable in compliance with Section 16100 Basic Materials and Methods.

1.2 SUBMITTALS:

a. Submit for approval manufacturer's data sheets for all conductor types. All wire shall be listed by an "approved" third party testing agency.

PART 2: PRODUCTS

2.1 MATERIALS:

a. Insulated conductors shall be as manufactured by Rome, Triangle, Southwire, or approved equal.

b. Unless otherwise indicated, all wire and cable conductors shall be copper.

c. Conductors shall be not smaller than #12 AWG except that #10 AWG minimum is required for the entire length of 120 volt branch circuits whose distance to the center of the load exceeds 75 feet. #14 AWG may be used for signal and remote control circuits. Other conductors that are smaller than #14 AWG may be used only where specifically indicated on the drawings or specified herein.

d. Conductors #10 AWG and smaller shall be solid, dual rated type THWN/THHN.

e. Conductors #8 AWG and larger shall be Class B stranded, dual rated type THWN/THHN.

f. Each conductor shall bear easily readable markings along entire length, indicating size and insulation type.

g. Insulation on conductors #10 AWG and smaller shall be suitably colored in manufacture.

h. Conductors in any location subject to abnormal temperature shall be furnished with an insulation type suitable for temperature encountered.

i. Where no indication is made of wire size, the conductor shall be of N.E.C. size to match its overcurrent protective device, but in no case smaller than #12 AWG.

PART 3: EXECUTION

3.1 SPLICES, TAPS, AND CONNECTIONS:

a. Splices in conductors #10 AWG and smaller shall be made with twist-on spring steel devices UL listed as Pressure Cable Connectors, with integral insulating covers rated 75°C at 600 volts, except that those used for connections to lighting fixtures and other heat-producing equipment shall comply with temperature ratings marked on the equipment but not less than 90°C.

b. Splices in copper conductors #8 AWG and larger shall be made with mechanical devices UL listed as Pressure Cable Connectors and insulated with thermoplastic tape UL listed for use as sole insulation. Tape may be omitted from connectors supplied with securely fastened insulating covers which completely enclose the connector and the conductors. Insulating covers shall be rated 75°C at 600 volts.

c. Connect solid wires to equipment, switches, and devices equipped with binding screw terminals by looping the wire under the screw head in such a manner that the loop is tightened as the screw is tightened. Straight-in wiring under screw terminals is not acceptable.

d. Stranded wires shall not be inserted into back-wiring holes on devices, nor shall they be directly connected to screw head terminals. They shall be fitted with insulated crimp-on type spade terminals for connection under the screw head.

3.2 COLOR CODING:

a. All wiring shall be color coded.

b. On 120/208V, 3 phase, 4 wire power systems, conductor insulation shall be color coded Black (Phase A), Red (Phase B), Blue (Phase C), and White (Neutral).

c. Insulation for grounding conductors on all systems shall be Green.

d. Conductors #8 AWG and larger may be identified with two or more bands of proper color plastic tape applied near each splice and termination. Painting of wire will not be acceptable.

e. Phase sequence shall be "A", "B" and "C" from left to right, top to bottom or front to back when facing equipment.

f. Control and signal wiring shall not use the above-named colors except green for grounding. Any other colors or striping may be used but the coding shall provide same color or striping between any two terminals being joined.

g. Switch legs, including "Travelers", shall be the same color as phase circuit conductors.

3.3 BRANCH CIRCUIT RACEWAY WIRING:

a. Three-phase circuits shall be limited to one such circuit per raceway. They shall consist of three different phase wires, and a neutral where required.

b. A neutral shall not serve more than one circuit. The neutral carrying all or any part of the current of any specific load shall be contained in the same raceway or enclosure with the phase wire or wires also carrying that current.

c. Circuits shall be connected to panels as shown in the panel schedules.

d. Conductors supplying lighting outlets may be combined in the same raceways with conductors supplying receptacles; but lighting outlets and receptacle outlets shall not be connected to the same circuits unless specifically indicated on the drawings.

3.4 SERVICE & FEEDER CONDUCTORS:

a. Unless specifically shown otherwise, each feeder and each set of service conductors shall be installed in a separate raceway.

b. Where paralleling of conductors is shown for feeders or service entrance, it is absolutely required they be exactly the same length between terminations.

c. Where service or feeder conductors are so installed that the conductor markings cannot be read without moving or twisting conductors, they shall be provided with suitable tags indicating the conductor size and insulation.

SECTION 16122

METAL-CLAD CABLE SYSTEMS

PART 1: GENERAL

1.1 SCOPE:

a. Furnish and install a complete system of Metal-Clad Cable for branch circuit, signal, and remote control wiring as specified herein. Comply with Section 16100 BASIC MATERIALS AND METHODS.

b. Other branch circuit cable systems such as Types AC, NM, and NMC are not permitted.

c. Metal Clad Cable shall not be used beyond the room of the served circuit and not for homeruns to panelboards.

1.2 APPLICATIONS:

a. Metal-Clad Cables may be used in lieu of wire in metal raceway only for concealed work in dry locations above suspended ceilings and within stud partitions.

b. Cables may not be run in, or through, concrete or masonry, fire-rated partitions, smoke partitions, or floors.

1.3 SUBMITTALS:

a. Submit for approval manufacturer's data sheets for metal-clad cable systems.

PART 2: PRODUCTS

2.1 MATERIALS:

a. Metal-Clad Cables shall be UL listed as type MC with copper conductors, THHN insulated; with full size green insulated grounding conductors. Minimum sizes shall be #12 AWG for branch circuits, #14 AWG for signal and remote control. Maximum size shall be #10 AWG.

b. Cable connectors shall be UL listed for grounding the metal sheath. Connectors shall be of steel or malleable iron with insulated throats.

c. Cables shall be color-coded in manufacture. Color-code shall comply with Section 16120 CONDUCTORS where feasible.

PART 3: EXECUTION

3.1 INSTALLATION:

a. Cables shall not be run exposed. Conduit skirts may be provided on surface mounted panelboards to conceal cables between panel tops and ceilings.

b. Except where installed in continuous rows, lighting fixtures shall be

individually connected to a concealed outlet box. Cables may not be looped from fixture to fixture.

c. Cables above ceilings shall be supported from overhead structure clear of ductwork, suspended ceilings, and ceiling hanger wires.

SECTION 16130

GROUNDING AND BONDING

PART 1: GENERAL

1.1 SCOPE:

a. All non-current-carrying metal parts, raceways, and enclosures shall be permanently and effectively grounded.

b. Grounding and bonding shall be provided in strict accordance with the National Electrical Code, and as specified herein and on the drawings.

c. The Contractor shall note that required grounding conductors and connections are not all shown on the drawings. NEC requirements apply.

PART 2: PRODUCTS

2.1 MATERIALS AND APPLICATIONS:

a. Grounding conductors shall be of THWN insulated copper, unless otherwise indicated.

b. Grounding bus bars in distribution equipment shall be bare copper.

c. Aluminum and aluminum alloys are not acceptable as grounding materials.

d. Clamps for attaching conductors to water pipes and ground rods shall be of bronze. Ground rod clamps shall be U.L. listed for direct burial.

e. Clamps for attaching conductors to building steel shall be of steel, bronze, or malleable iron.

f. Threaded hubs for bonding metal raceways to the contained grounding electrode conductors and to the water pipe clamps shall be of bronze or malleable iron. Similar hubs shall be used to bond the same raceways to the conductors and to sheet metal equipment enclosures.

g. Driven grounding electrodes shall consist of copper clad steel rods. Rods shall be 10 feet long and 3/4" diameter unless otherwise indicated.

h. Bonding bushings shall be of steel or malleable iron with non-removable plastic throats rated 150°C.

i. Bonding locknuts and wedges for service conduits shall be of zinc coated steel.

PART 3: EXECUTION

3.1 ELECTRICAL EQUIPMENT GROUNDING:

a. All non-current-carrying metal parts, raceways, and enclosures of the

electrical system and of equipment supplied through the electrical system shall be permanently and effectively grounded.

b. Equipment grounding conductors shall be provided for each feeder and for each branch circuit and shall be contained within the same raceways as the feeder and branch circuit conductors. The equipment grounding conductor shall be THWN insulated copper, not smaller than #12 AWG.

c. Copper bonding strips normally included in small sizes of liquid-tight flexible metal conduit and dependent upon the terminal connectors for bonding continuity will not be accepted in lieu of the equipment grounding conductors specified herein.

d. Grounding terminals on wiring devices, other than isolated ground receptacles, but including switches, shall be connected to the equipment grounding conductor included in the branch circuit raceway, and to the device box with suitable jumpers and lugs bolted to the box, not the plaster ring. "G" clips are not acceptable, and "self-grounding" type device mounting screws will not be accepted as the device grounding method.

e. Where metal raceways enter sheet metal enclosures through knockouts provide bonding bushings and jumpers to the enclosure.

SECTION 16140

BOXES

PART 1: GENERAL

1.1 SCOPE:

a. Furnish and install outlet boxes, switch boxes, pull boxes, terminal boxes, junction boxes and floor boxes complete as shown and specified.

1.2 SUBMITTALS:

a. Submit for approval manufacturer's data sheets for all box types.

PART 2: PRODUCTS

2.1 MATERIALS AND APPLICATIONS:

a. Unless specifically noted or approved otherwise, boxes shall be of zinc coated steel or cast ferrous alloy as manufactured by Steel City, Raco, Crouse-Hinds, Appleton, or approved equal.

b. For exposed work on the exterior of the building, and in damp or wet interior locations, boxes shall be of cast metal with threaded conduit hubs and gasketed covers; or of zinc coated sheet steel of NEC gauge and size with screw fastened gasketed covers and threaded conduits hubs of zinc coated malleable iron and no knockouts or extraneous openings. Cover screws shall be stainless steel.

c. For exposed work in interior dry locations less than 8 feet above a floor or platform in other than Electrical, Mechanical or Communications Closets or Equipment Rooms, boxes shall be of cast metal with threaded conduit hubs and matching covers; or of zinc coated sheet steel of NEC gauge and size with screw fastened covers and no knockouts or extraneous openings. Cover screws shall be steel.

d. For exposed work in interior dry locations in Electrical, Mechanical, or Communications Closets or Equipment Rooms; or, in other dry areas, 8 feet or more above a floor or platform, boxes 5" square and larger shall be NEC gauge and size of zinc coated sheet steel. 4" octagonal, 4" square and 4-11/16" square "knockout" boxes shall be of zinc coated steel, NEC gauge and size. Box extensions are not permitted on exposed "knockout" boxes, and covers shall be of the raised surface type. "Handy" boxes are not permitted.

e. For concealed work, fixture outlet boxes shall be 4" octagonal minimum, provided with plaster rings in plastered surfaces. Concrete ring boxes shall be used in poured concrete. Switch and outlet boxes in plastered and dry walls shall be 4" square minimum or one-piece multi-gang with appropriate plaster rings. Switch and outlet boxes in exposed brick, block or tile walls shall be single or multi-gang one-piece boxes not less than 3-1/2" deep with square corners and with internal device mounting holes, equal to Steel City Type GW. Boxes in walls finished with ceramic tile or wood paneling shall be 4" square minimum or one-piece multi-gang boxes, fitted with appropriate tile rings having square corners and internal device mounting holes. Gangable boxes

are not permitted.

f. Floor boxes on ground slab shall be cast-iron, approved for use on grade. The boxes shall be 14-1/2" L x 11-7/8" W x 3-7/16" H. There shall be four independent wiring compartments that allow capacity for up to four duplex receptacles and/or communication services. The floor boxes shall permit tunneling from adjacent or opposite compartments. Two of the four compartments shall have a minimum wiring capacity of 27 cu. in. and two compartments shall have a minimum wiring capacity of 36 cu. In. The boxes shall provide the following number of conduit hubs: four 1" and four 1-1/4". The boxes shall be fully adjustable, providing a maximum of 1-7/8" pre-pour adjustment, and a maximum of ¾" after-pour adjustment. Activation covers shall be manufactured of die-cast aluminum with a brushed aluminum finish. Activation covers shall be available in flanged and flangeless versions. Covers shall be available with options for tile or carpet inserts, flush covers, or covers with one 1" trade size screw plug opening and one combination 1-1/4" and 2" trade size screw plug openings for furniture feed applications. Flanged covers shall be 7 ¾" L x 6-9/16" W. Flangeless covers shall be 6-3/4" L x 5-9/16" W. The boxes shall provide a series of device mounting communication plates that will accept both duplex power devices, as well as plates that will accommodate outlets and modular inserts. Wiremold RFB4-CI-1 or equal.

PART 3: EXECUTION

3.1 INSTALLATION:

a. Set recessed boxes with edges flush with finished surfaces.

b. Immediately after installation cover boxes to prevent entrance of foreign matter.

c. Scaling of plans for outlet locations is not necessarily accurate enough for the intent of these specifications. It is the Contractor's responsibility to comply with the evident intent for centering or symmetric arrangement in ceiling and wall spaces. Special attention is also directed to the location of any outlets which are built into, or located in relation to, other features such as shelving, work counters, and equipment. The Contractor shall consult plans and shop drawings on such features and locate outlets as thereby indicated.

d. Mounting heights indicated herein and on the drawings are approximate dimensions of the center of the box to the floor, and may vary slightly in order to clear obstructions and match joints in masonry. References to "Horizontal" and "Vertical" apply to the orientation of the long dimension of a single-gang plate and of the device mounting strap. Alignment tolerance shall be 1/16 inch.

1. Wall receptacle, data, and telephone outlets shall, unless otherwise indicated, be installed vertical, 18" up.

2. Outlets indicated as "counter height," as well as boxes for wall switches, fire alarm manual stations, and wall telephones shall be installed vertical, 46" up, clear of wall cabinets, back-splashes, and wainscot interferences.

e. Switch boxes beside doors shall be on the strike side, with edge approximately 2" from door jamb or trim.

f. Junction and pull boxes may be used as necessary to facilitate wiring provided they are hidden from sight (but accessible), or installed in locations where exposed wiring is permitted, or flush mounted at locations approved by the Architect/Engineer.

SECTION 16150

WIRING DEVICES

PART 1: GENERAL

1.1 SCOPE:

a. The Contractor shall furnish and completely install lighting switches, convenience outlets, and special purpose receptacles along with appropriate outlet boxes and device plates as indicated on the drawings and as herein specified.

b. Where connection to an item of equipment is required under this contract, and where such equipment requires a receptacle for connection, the Contractor shall furnish and install the appropriate device, whether or not the device is specifically shown or specified.

1.2 SUBMITTALS:

a. Submit for approval catalog data sheets for all wiring devices.

PART 2: PRODUCTS

2.1 MANUFACTURERS:

a. Wiring devices and device plates shall be manufactured by Hubbell, Bryant, Arrow Hart, Pass and Seymour, Leviton, or Eagle.

b. Catalog numbers of one or more of the manufacturers are used herein and on the drawings to set a standard of quality and capacity. Equivalent products of the other named manufacturers are also acceptable, provided they are submitted and approved in accordance with Section 16010, Electrical General Requirements.

c. All wiring devices of any one general type (e.g. all duplex receptacles or all light switches) shall be of the same manufacturer, and shall match throughout.

2.2 WIRING DEVICES AND PLATES - GENERAL:

a. Wiring devices shall be industrial specification grade unless otherwise indicated.

b. Unless otherwise indicated or directed, wiring devices shall be gray in color.

c. Unless otherwise indicated, plates for flush outlets shall be of no. 302 stainless steel and shall be standard size. Those for surface cast boxes shall be of steel, of shape and finish to match the box. Screws shall be steel slotted head oval type to match the plate. Quantity of 2% spare cover plates of each type shall be provided to the owner.

d. Each wiring device (including each switch) shall be equipped with a

Hex-Head green grounding screw for grounding the device and plate to the outlet box and to the equipment grounding conductor run with the circuit conductors. "Self-Grounding" type mounting screws will not be accepted as the device grounding method.

2.3 SWITCHES:

a. Switches used for lighting control shall be listed to Fed Spec W-S-896E and rated 20 amps, 120-277 VAC, side wired, Hubbell 1221 series.

b. Switches used for disconnecting small single-phase motors and appliances shall be listed to Fed Spec W-S-896E and rated 20 or 30 amps to match the branch circuit rating and comply with their horsepower ratings, 120-277 VAC, side wired, Hubbell 1221 and 3031 series.

c. Weatherproof switches shall be equipped with stainless steel covers UL listed for wet locations with cover closed, Pass and Seymour WP-1.

d. Key operated switches shall be Hubbell 1221-L series.

e. Switches with collars around the operating toggle will not be accepted.

2.4 RECEPTACLES:

a. Receptacles shall be listed to UL498 and Fed Spec W-C-596. Unless otherwise indicated or required, receptacles shall be the duplex type, side and back wired, with nylon face. On circuits supplying two or more such receptacles, they shall be rated 15 amps, 125 volts, NEMA 5-15R. Duplex receptacles on individual circuits shall be rated 20 amps, 125 volts, NEMA 5-20R. Receptacles shall conform to NEMA WD-1, WD-6 and UL498.

b. Where no other features are indicated on the drawings provide Hubbell 5262 and 5362 series for 5-15R and 5-20R respectively.

c. Where indicated on the drawings provide Ground Fault Circuit Interrupter receptacles, Hubbell GF5262 and GF5362 series for 5-15R and 5-20R respectively. GFCI receptacles shall be Class A, listed to UL standard 943.

d. Where indicated on the drawings provide weatherproof receptacles consisting of Ground Fault Circuit Interrupter receptacles as specified above with stainless steel covers UL listed for wet locations with cover closed, Pass and Seymour CA2-GH.

e. Where indicated on the drawings provide Isolated Ground Receptacles, Hubbell IG5262 and IG5362 series for 5-15R and 5-20R respectively.

PART 3: EXECUTION

3.1 INSTALLATION:

a. Devices shall be mounted tightly to boxes and be adjusted plumb and level. Devices shall be mounted flush with its associated coverplate. Ears on

flush devices shall be in uniform contact with wall surfaces, or the devices shall be fitted with Caddy RLC device levelers. Device plates shall not be used for support of flush devices.

b. Where two or more devices are indicated for gang installation, they shall be trimmed with gang type plates.

c. Grounding type receptacles shall be grounded with insulated copper grounding conductors routed with the circuit conductors.

d. The Contractor shall provide suitable testers, and demonstrate, when directed, that receptacles are operational and correctly wired; and that ground fault circuit interrupter type receptacles will trip when current to ground has a value in the range of 4 through 6 milliamperes.

SECTION 16160

RACEWAY AND OUTLET SYSTEMS

PART 1: GENERAL

1.1 SCOPE:

a. Contractor shall furnish and install systems of raceways, outlet boxes, equipment boards, and cabinets, as indicated on the drawings and as herein specified to accommodate the installation of wiring and equipment.

PART 2: PRODUCTS

2.1 MATERIALS:

a. Raceways, and boxes, shall be in compliance with the relevant sections of these specifications.

b. Wall outlets shall consist of standard 4" x 4" x 2-1/2" outlet boxes with single device rings. Trim plates shall be blank to match wiring device trim plates, unless otherwise indicated.

c. Special outlets including floor outlets shall be as noted on the drawings.

PART 3: EXECUTION

3.1 COORDINATION:

a. Contractor shall fully coordinate with other installers of wiring and equipment and shall install raceways, outlets, cabinets, and backboards in accordance with their requirements.

3.2 INSTALLATION:

a. Install pull boxes as necessary to limit runs between pull points to two 90 degree bends (or equivalent) and to 100 feet in length, unless other arrangements are approved by the wiring installers.

b. Leave all raceways with 100 lb. test nylon pull cord.

c. Install raceways and boxes in accordance with relevant sections of these specifications.

d. Unless specifically noted otherwise, provide an individual 1" conduit from each indicated outlet to the nearest cable tray, equipment cable tray, cabinet or terminal board for the system involved.

e. Provide all conduits not terminating on boxes with plastic bushings.

f. At the equipment terminal board, terminate all conduits with plastic bushings.

SECTION 16190

MISCELLANEOUS MATERIALS

PART 1: GENERAL

1.1 SCOPE:

a. Contractor shall furnish and install miscellaneous materials as indicated on the drawings and as herein specified.

1.2 SUBMITTALS:

a. Submit for approval manufacturer's data sheets on each device specified by this section.

PART 2: PRODUCTS

2.1 CONTROL RELAYS:

a. The relay coil shall operate satisfactorily with coil voltages within 85% to 110% of its voltage rating. Unless otherwise noted, contact rating shall be 10 amps, continuous for the applied voltage level.

b. Time delay relays shall be provided with on-delay or off-delay as required and repetitive accuracy of plus or minus 0.2%.

c. Relays shall be installed in a suitable enclosure to fit the environment of their location.

d. Relays shall be manufactured by GE, Square D, Cutler-Hammer or approved equal.

2.2 CONTACTORS:

a. Contactors shall be "electrically held" or "mechanically held" type, as indicated on drawings.

b. Electrically held contactors shall include auxiliary contacts as indicated and line and load terminal connectors.

c. Mechanically held contactors shall be industrial type, single or dual solenoid operator, with mechanism capable of withstanding reduction or loss of control voltage without change of position. Contactor shall incorporate control power cut-out contacts so that the magnetic solenoid operator is only momentarily energized during the instant the switch changes position.

d. Contactor core and coil assembly, or operators, shall operate satisfactorily with coil voltage within 85% or 110% of its voltage rating.

e. All contacts shall be of non-welding, non-corroding silver alloy.

f. Rating of contactors shall be as indicated on drawings. Auxiliary relays shall be provided as applicable. Contactors shall be contained in a

suitable enclosure for the environment of their location. Contactors shall be suitable for a continuous load not less than 100% of their electrical rating.

g. Contactors shall be manufactured by GE, Square D, Cutler-Hammer or approved equal.

2.3 INDIVIDUAL PUSHBUTTONS, SELECTOR SWITCHES AND INDICATING LIGHTS:

a. Pushbuttons shall be heavy-duty, oil-tight, momentary or maintained contact, as applicable, devices rated 600 volts with the number of buttons and the marking of nameplates in accordance with NEMA Publication No. ICS.

b. Pushbuttons shall be designed with the indicated number of normally open circuit closing contacts, normally closed circuit opening contacts, or combination thereof. Pushbuttons shall have positive make and break non-welding, non-corroding silver alloy contacts.

c. Selector switches for control circuits shall be heavy-duty, oil-tight maintained contact devices with the number of positions and the marking of nameplates as indicated on drawings or otherwise specified.

d. Indicating lights for control circuits shall be oil-tight, instrument type devices with threaded base and collar for flush mounting and translucent convex lens. Indicating lights shall be long life type, rated 7500 hours, minimum. Provide Owner with two spare indicating lights of each size and type used.

e. Pushbuttons, selector switches and indicating lights shall be contained in an enclosure suitable for the environment of their location, and shall be Square D Class 9001, Type T Series, or equivalent as accepted by the A-E, and shall be Square D Class 9001, Type T Series, or approved equal.

2.4 CONTROL CIRCUIT TRANSFORMERS:

a. Control circuit transformers shall be provided within the enclosure of magnetic contactors when indicated on drawings or specified otherwise and the line voltage is in excess of 120 volts. The transformer shall be dry type single phase, 60 hertz alternating current with a 120 volt isolated secondary winding in accordance with NEMA Publication No. STL "Specialty Transformers".

b. The rated primary voltage of the transformer shall be not less than the rated voltage of the controller. The rated secondary current of the transformer shall be not less than continuous duty current of the control circuit.

c. The voltage regulation of the transformer shall be such that with rated primary voltage and frequency the secondary voltage will not be less than 95% or more than 105% of rated secondary voltage.

d. The source of supply for control circuit transformers shall be taken from the load side of the main disconnecting device. The primary and secondary windings of the transformer and control circuit wiring shall be protected against overloads and short circuits with properly selected fuses. The secondary winding of the control circuit transformer shall be grounded.

2.6 PROGRAMMABLE LIGHT SWITCHES:

a. The digital time switch shall be programmable to turn lights off after a preset time.

b. Time switch shall be a completely self-contained control system. It shall have a ground wire and ground strap for safety. Switching mechanism shall be a latching air gap relay.

c. Time switch shall be compatible with all electronic ballasts, motor loads, compact fluorescent and inductive loads.

d. Time switch shall operate at universal voltages of 100-300 VAC; 50/60 Hz.

e. Time switch shall have no minimum load requirement and shall be capable of controlling 0 to 800 watt incandescent, fluorescent @ 100/120 VAC, 50/60 Hz; 0 to 1200 watts fluorescent @ 230/277 VAC, 50/60 Hz; 1/6 hp @ 125 VAC.

f. Time scroll feature shall allow manual overriding of the preset time-out period.

g. Time switch shall have the option for a one second light flash warning at five minutes before the timer runs out and twice when the countdown reaches one minute (when used to control lighting loads).

h. Time switch shall have the option for a beep warning that shall sound every five seconds once the time switch countdown reaches one minute.

i. Time switch shall have manual feature for timer reset where pressing the ON/OFF switch for more than 2 seconds resets the timer to the programmed time-out period.

j. Time switch shall have an electroluminescent backlit Liquid Crystal Display that shows the timer's countdown.

k. Time-out period shall be adjustable increments of 5 minutes from 5 minutes to 1 hour, and in increments of 15 minutes from 1 hour to 12 hours.

l. Time switch shall be capable of operating as an ON/OFF switch.

m. The time switch shall have a 100% OFF override switch with no leakage current to the load.

n. In the event there is an open circuit in the AC line such as a ballast or lamp failure, the time switch shall automatically switch to OFF mode.

o. Time switch shall have 5 year warranty and shall be UL and CUL listed.

2.7 SPECIAL ENCLOSURES:

a. Special enclosures designed in accordance with UL and NEMA Standards shall be provided as required to protect devices and equipment from wet, dusty, corrosive, hazardous or flammable atmospheres. Enclosures shall be NEMA Type 3R,

3S, 4X, 7, 9, 12, or 13 in accordance with the environment present in the specific location.

b. Enclosures shall be made of metal unless otherwise specifically noted.

c. NEMA Type 4X enclosure shall be made of corrosion-resistant, chromium nickel stainless steel conforming with UL Standard No. 50 "Cabinet and Boxes".

d. NEMA Type 7 and 9 enclosures shall be made of cast iron, bolted-type UL listed for the use intended. Cast metal enclosures shall be not less than 1/8" thick at every point, except that it shall be not less than 1/4" thick at tapped holes for conduits.

2.8 OCCUPANCY SENSORS:

a. Occupancy sensors shall be provided where indicated on the drawings. Sensors shall be the dual technology type suitable for sensing both passive infrared and ultrasonic wave type, complete with a self-contained power/switch unit to avoid the need for low-voltage wiring to a remote sensor. Each sensor shall have a time delay circuit adjustable from 6 - 15 minutes with a shortened 30 second time delay feature for set-up purposes and a manual time delay bypass feature. In addition, each sensor shall have a LED walk test indicator for set-up purposes.

b. The power/switch pack shall consist of a control transformer and rectifier circuit and a relay with contacts rated 277 VAC, 20 Amp, 4800 Watts.

c. The sensor shall be sensitive to 9 - 10 micron/meter wave length infrared heat waves.

d. Upon detection of the heat waves or motion, the relay contacts shall instantly close to activate the room lighting. The contacts shall remain closed until no motion or presence of waves is sensed for the full length of time set by the adjustable time delay circuit.

e. The sensor shall be ceiling mounted and located as recommended by the manufacturer. The sensor shall be provided complete with all necessary hardware, brackets, special boxes and covers.

f. Unless otherwise indicated, all fluorescent lighting within the room where the occupancy sensor is located shall be controlled by the occupancy sensor.

PART 3: EXECUTION

3.1 INSTALLATION:

a. Devices specified by this section shall be installed such that only one wire is terminated on any given screw.

SECTION 16400

SECONDARY DISTRIBUTION EQUIPMENT

PART 1: GENERAL

1.1 SCOPE:

a. Provide equipment for over-current protection, switching, disconnecting, transformation, and control of services, feeders, and branch circuits as indicated on the drawings and as herein specified.

b. Equipment specified by this section shall be third party listed.

PART 2: PRODUCTS

2.1 MANUFACTURERS:

a. Distribution equipment, other than fuses, shall be manufactured by Square D, General Electric, Siemens, or Cutler-Hammer. Equipment design features and components indicated on the drawings are those of Cutler-Hammer, and the standard construction features of that manufacturer shall be considered as minimum requirements, with additional requirements as specified herein and on the drawings.

b. Fuses shall be manufactured by Bussmann, Gould Shawmut, or Littelfuse.

2.2 OVER-CURRENT PROTECTION DEVICES:

a. Unless otherwise indicated, circuit breakers shall be provided as the over-current protection devices for services, separately derived systems, feeders, and branch circuits. Fuses may be used only where indicated on the drawings, or required by the nameplate for equipment connected, or specified herein.

b. Molded-case and insulated-case circuit breakers shall be the static or thermal-magnetic type, quick-make and quick-break for manual and automatic operation. Multi-pole breakers shall be common trip. Circuit breakers shall be bolted in place where possible. Thermal-magnetic breakers shall be calibrated at 40°C or ambient compensated. Ampere ratings, frame sizes, and short circuit ratings shall be as indicated on the drawings. Series ratings may be applied only where specifically indicated on the drawings. Individual enclosures shall be NEMA 1 indoors, 3R outdoors, unless otherwise indicated. Other circuit breakers shall be suitable for installation in Switchboards, Panelboards, and Motor Control Centers as hereinafter specified.

c. Single-pole 15 and 20 amp circuit breakers shall be SWD rated.

d. Fuses shall be the non-renewable, time delay, cartridge type, UL Class RK5 unless otherwise indicated; for installation in Safety Switches, as hereinafter specified.

2.3 SWITCHING EQUIPMENT:

a. Fusible switches shall be incorporated into Safety Switches, as hereinafter specified. Manual operation shall be quick-make and quick-break. Fuse holders shall be the Class R rejection type unless otherwise indicated.

b. Safety Switches shall be the NEMA heavy duty type, horsepower rated, with interlocked covers, non-fusible except where fused switches are indicated or fuses are required. Switch mechanisms shall be quick-make and quick-break. Enclosures shall be NEMA 1 indoors, NEMA 3R outdoors unless otherwise indicated. Fuse holders, where required, shall be as specified above for fusible switches.

c. Switches for disconnecting small single-phase motors and appliances shall comply with SECTION 16150 WIRING DEVICES.

2.4 APPLICATION:

a. Distribution Equipment shall be sized for installation with required clearances at the locations shown on the drawings. Alternative arrangements may be submitted to the Architect/Engineer by the Contractor for approval, in the form of shop drawings, drawn to scale and showing actual dimensions of proposed equipment and required clearances.

b. Unless otherwise indicated, Distribution Equipment shall be connected with wire and cable as specified in SECTION 16120 CONDUCTORS. In general, these specified conductors are rated for a maximum operating temperature of 75°C, and are sized for that temperature rating in an ambient of 30°C. Distribution equipment, including terminal lugs, temperature sensitive devices, and enclosures shall be designed, sized, and labeled for field connection with conductors as specified.

c. Power conductors shall be properly tightened and/or torqued as recommended by the equipment manufacturer supplying the lugs/terminals used for terminating the conductors.

d. Lugs/terminals shall comply with UL standards UL486A and UL486B.

2.5 IDENTIFICATION:

a. Equipment nameplates; and nameplates for individually mounted switches, circuit breakers, and motor starters in Switchboards and Motor Control Centers; shall comply with SECTION 16100 BASIC MATERIALS AND METHODS.

b. Group mounted switches and circuit breakers in Panelboards and Switchboards shall be provided with nameplates as described above; or they shall be identified with numerals and cardboard directories in metal or heavy polycarbonate, directory frames. Directories in metal frames shall be protected with rigid plastic covers. Directories shall be sized to permit all circuit designations to be read without removing the card from the frame.

c. Manufacturer's nameplates or labels on custom fabricated or factory assembled custom equipment shall contain sufficient identification to expedite the future procurement of parts, additions, and shop drawings.

PART 3: EXECUTION

3.1 INSTALLATION:

a. Distribution Equipment shall be installed in strict accordance with the manufacturer's instructions for handling, support, connections, assembly, protection, energization, adjustment, and similar procedures.

b. Fastening methods shall comply with SECTION 16100 BASIC MATERIALS AND METHODS.

c. Equipment interiors shall be thoroughly cleaned of dust, dirt, trash, and other foreign material prior to energization of the equipment.

d. Exterior Safety Switches that are readily accessible to unauthorized persons shall have their covers padlocked closed by the Contractor. Keys shall be identified and delivered to the Owner.

e. Upon completion or the project, furnish to the Owner one complete set of replacement fuses, consisting of three fuses of each type and rating used.

f. Directory cards for Panelboards shall be neatly filled-in with a typewriter to indicate the type and location of the load on each circuit or feeder.

SECTION 16420

PANELBOARDS

PART 1: GENERAL

1.1 SCOPE:

a. Furnish and install Lighting, Power, and Distribution Panelboards as indicated on the drawings and as herein specified.

b. Panelboards and their installation shall comply with applicable requirements of SECTION 16400 - DISTRIBUTION EQUIPMENT.

1.2 SUBMITTALS:

a. Submit for approval panelboard shop drawings which include as a minimum the following information:

1. Cabinet dimensions.

2. Mounting requirements.

3. Bussing arrangement.

4. Circuit breaker arrangement.

5. Accessories.

PART 2: PRODUCTS

2.1 BRANCH CIRCUIT PANELBOARDS:

a. Panelboard types, ratings, and contents shall be as shown on the Drawings.

b. Equipment shall be built to NEMA Standard PB-1, UL Standards UL50 and UL67, and NEC requirements.

c. Panelboard back-boxes shall be constructed of galvanized sheet steel and shall be securely fabricated with screws, bolts, rivets, or by welding. Back-boxes shall be a minimum 20" wide and 5-3/4" deep, unless noted otherwise, and heights shall not exceed 72" overall. Top or bottom gutter space shall be increased 6" where feeder loops through panel. End plates shall be supplied without knockouts.

d. Covers shall be constructed of high grade flat sheet steel with:

1. Door-in-door construction shall be provided. The inside hinge door shall allow access to device handles only. Door shall close flush with cover and against a full inside trim stop. Hinges shall be inside type. The outer hinged door shall allow access to wiring gutter.

2. A flush latch and tumbler type lock, so panel door may be

held closed without being locked. All such locks shall be keyed alike. Furnish to the Owner two keys with each lock, or a total of 10 keys for the project.

3. Four or more cover fasteners of a type which will permit mounting plumb on box. Cover shall also have inside support studs to rest on lower edge of back-box while being fastened. For flush mounted panelboards, cover fastening hardware shall be concealed behind the hinged door.

e. A means shall be provided for readily adjusting projection of panel interior assembly with all connections in place. A method requiring stacking of washers is not acceptable. Interior trim shall fit neatly between interior assembly and cover leaving no gaps between the two.

f. Panelboard phase and neutral bus bus-work shall be of copper. A copper ground bus shall be provided in each panel.

g. Minimum short circuit rating of any panelboard assembly shall be 10,000A. Furnish panelboards with higher rating where so noted or where evidently intended by specification of circuit breakers with higher interrupting capacity.

h. Ampacity of mains shall be equal to, or greater than, the ampacity of the feeder unless otherwise indicated.

i. Where drawings schedules indicate spaces for addition of future circuit breakers, furnish all necessary bus-work, strap, brackets, hardware, and removable blank covers.

j. Breakers in panelboards shall be physically arranged in locations shown in panel schedules on the drawings where possible. They shall be connected to the phases as shown.

k. Unless otherwise indicated and where available for the panelboard type specified, circuit breakers shall be of the bolt-on type.

PART 3: EXECUTION

3.1 INSTALLATION:

a. Equipment shall be perfectly plumb and level.

b. Openings in back-boxes shall be cut or sawed with tools made for that purpose. Burning of openings is absolutely unacceptable.

c. Unused openings shall be closed.

d. Only one solid wire is allowable under a screw. Provide approved lugs for connecting stranded wire or more than one solid conductor.

e. Centered above the breakers in each panelboard attach a nameplate indicating panel designation - for example "PANEL A", or "PANEL MDP". Nameplates shall comply with SECTION 16100 BASIC MATERIALS AND METHODS.

f. Panelboard back-boxes shall be mounted with their tops 6'-8" above

the floor.

16SECTION 16500

LIGHTING FIXTURES AND ACCESSORIES

PART 1: GENERAL

1.1 SCOPE:

a. The Contractor shall furnish and completely install Lighting Fixtures and Accessories as indicated on the drawings and as herein specified.

b. All fixtures shall be equipped with lamps.

c. A lighting fixture shall be provided for each lighting outlet indicated. Outlets lacking fixture designations shall be brought to the attention of the Architect/Engineer before submitting proposal; otherwise units selected by the Architect/Engineer shall be furnished and installed at no additional charge.

1.2 SUBMITTALS:

a. Submit for approval complete manufacturer's data sheets for all fixtures. Indicate all components, characteristics, and options.

b. Submit for approval manufacturer's data sheets for all lamps to be furnished.

c. Submit for approval Lighting Fixture samples as requested by the Architect/Engineer. Samples shall be equipped with lamps, cords, plugs, and ballasts for 120 volt operation.

PART 2: PRODUCTS

2.1 LIGHTING FIXTURES:

a. All fixtures shall be labeled by Underwriters' Laboratories, Inc. or other acceptable testing agency.

b. Fixture designations on the drawings generally consist of a letter indicating the fixture type. Fixture types are identified in the Lighting Fixture Schedule or Symbol Schedule, however, the Schedule does not necessarily list all accessories and hardware necessary for the complete installation, nor does it detail the construction to be encountered at the fixture locations. It is the Contractor's responsibility to properly determine and provide correct components, accessories, and hardware required for the installation.

c. Plastic materials indicated to be "acrylic" shall be of 100% virgin methyl methacrylate produced by Rohm and Haas, Dupont, or Cyanamid.

d. Fluorescent fixtures containing three or more lamps shall be ballasted and connected to permit separate switching of center lamp in three-lamp units, two center lamps in four-lamp units.

e. A disconnecting means shall be provided as a part of the UL listed fixture package for all fluorescent ballasted fixtures that will disconnect simultaneously from the source of supply all conductors of each ballast including the ground conductor as required by NEC 410.73(G).

2.2 LAMPS:

a. Lamps shall be manufactured by Osram Sylvania, General Electric, or Philips.

b. Lamps shall be compatible with the design and photometric characteristics of the lighting fixtures. Where the lighting fixture design offers a choice of lamps, the lamp selection shall be as directed by the Architect/Engineer.

c. Unless otherwise indicated, nominal 4-foot "Building Standard" fluorescent lamps shall be the 28 watt, T8 instant start type or rapid start type as indicated with a 3500°K color temperature and a minimum 75 color rendering index and fully compatible with the ballasts supplied.

2.3 BALLASTS:

a. Ballasts for fluorescent lamps shall be manufactured by Advance, Jefferson, Magnetek, or approved equal. All fixtures of the same type shall be supplied with ballasts of the same manufacturer.

b. Fluorescent ballasts shall be High Power Factor, UL listed and labeled, and designed for operation at 120 or 277 volts as applicable, unless otherwise indicated.

c. Fluorescent ballasts, unless otherwise indicated, shall be the electronic type, Class P, Sound Rated A, with Ballast Efficacy Factors in compliance with NAECA Requirements. Electronic ballasts shall provide high frequency operation with lamp current crest factors of 1.7 or less and total harmonic distortion of less than 20%. Light output and noise levels shall comply with CBM standards for equivalent electromagnetic ballasts.

f. Ballasts shall withstand line transients per IEEE 587, Category A and shall meet FCC Rules and Regulations, Part 18.

g. Ballast case temperature shall not exceed 25 degrees C. rise over 40 degrees C. ambient.

h. Ballasts for 28 watt fluorescent lamps shall be Program Rapid Start where controlled by occupancy sensors, Instant Start elsewhere.

2.4 EMERGENCY EXIT LUMINARE:

a. It shall be completely self-contained, provided with maintenance-free battery, automatic charger, and other features. Luminaire must be third-party listed as emergency lighting equipment, and meet or exceed the following standards; NEC, N.C. Building Code, Volume X Energy Code, NFPA-101, and NEMA

Standards.

b. Battery shall be sealed, maintenance-free type, with minimum of 90 minutes operating endurance. Battery shall have a normal life expectancy of 10 years. Batteries shall be high temperature type with an operating range of 0 degree C to 60 degrees C and contain a re-sealable pressure vent, a sintered + positive terminal and - negative terminal.

c. Charger shall be full automatic solid state type, full wave rectifying, with current limiting. Charger shall restore the battery to its full charge within 24 hours after a discharge of 90 minutes under full rated load. The unit shall be activated with the voltage drops below 80 percent. A low voltage disconnect switch shall be included if LEAD Battery is used, to disconnect the battery from the load and prevent damage from a deep discharge during extended power outage.

d. Pilot light shall indicate the unit is connected to AC power. The battery shall have high rate charge pilot light, unless self-diagnostic type. Tests switch shall simulate the operation of the unit upon loss of A.C. power by energizing the lamps from the battery. This simulation must also exercise the transfer relay.

e. The entire unit shall be warranted for three years. The battery must have an additional two more years' pro-rated warranty. Warranty shall start from the date of project final acceptance. Warranty shall be included in the contract document.

f. The use of LED is required due to their reliable performance, low power consumption, and limited maintenance requirements. Maximum LED failure rate shall be 25% within a seven (7) year period; otherwise, if exceeded, manufacturer shall replace the complete unit at no charge to the owner.

g. Contractor shall perform a test on each unit after it is permanently installed and charged for a minimum of 24 hours. Battery shall be tested for 90 minutes. The battery test shall be done 10 days prior to final inspection. Any unit which fails the test must be repaired or replaced, and tested again. The test shall demonstrate that the batteries conform to the requirements of NEC 700.12 (F).

2.5 EMERGENCY EGRESS LUMINARE:

a. Shall be completely self-contained, provided with maintenance-free 12 volt battery, automatic charger, two lamps, and other features. Luminaire shall be third-party listed as emergency lighting equipment, and meet or exceed the following standards: NEC, N.C. Building Code, Volume X Energy Code, NFPA-101, and NEMA Standards.

b. Pilot light shall indicate the unit is connected to A.C. power. The battery shall have high rate charge pilot light, unless self-diagnostic type. A test switch shall simulate the operation of the unit upon loss of A.C. power by energizing the lamps from the battery. This simulation must also exercise the transfer relay. If fluorescent emergency unit is used, an LED charging indicator light must be easily visible after installation and a remote test

switch shall be installed adjacent to the fixture.

c. Battery shall be sealed, maintenance free type, with minimum of 90 minutes operating endurance. Battery shall have a normal life expectancy of 10 years. Batteries shall be a high temperature type with an operating range of 0 degree C to 60 degrees C and contain a re-sealable pressure vent, a sintered + positive terminal and - negative terminal.

d. Charges shall be fully automatic solid state type, full wave rectifying, with current limiting. Charger shall restore the battery to its full charge within 24 hours after a discharge of 90 minutes under full rated load. The unit shall be activated when the voltage drops below 80%. A low voltage disconnect switch shall be included if LEAD battery is used, to disconnect the battery from the load and prevent damage from a deep discharge during extended power outage.

e. The entire unit shall be warranted for three years. The battery must have an additional two more years' pro-rated warranty. Warranty shall start from the date of project final acceptance. Warranty shall be included in the contract document.

f. Contractor shall perform a test on each unit after it is permanently installed and charged for a minimum of 24 hours. Battery shall be tested for 90 minutes. The battery test shall be done 10 days prior to final inspection. Any unit which fails the test must be repaired or replaced, and tested again. The test shall demonstrate that the batteries conform to the requirements of NEC 700.12 (F).

PART 3: EXECUTION

3.1 COORDINATION:

a. Contractor shall verify ceiling or wall type in or on which each fixture is to be mounted, and shall furnish unit with appropriate trim type, mounting hardware, and accessories to fit the construction; and feed through junction boxes as required to maintain proper access to system wiring.

3.2 INSTALLATION:

a. Lighting fixtures shall be installed in accordance with the manufacturer's instructions.

b. Lighting fixtures shall be supported from the building structure using corrosion resistant steel hardware in compliance with Section 16100, Basic Materials and Methods.

c. A minimum of two No. 12 gauge wire supports attached to the structure shall be provided for each lighting fixture unless otherwise indicated or approved by the Architect/Engineer. The supports shall be located at diagonal corners of rectangular fixtures and angled away from fixture. A minimum of three full twists shall be made at each end to secure wire.

d. In addition to the supports from the structure, fixtures shall also

be secured to suspended ceilings on which they are mounted, or in which they are recessed. Where fixtures are secured to suspended ceilings, the primary supports from the building structure shall be slack.

e. Where installed recessed in grid type ceilings, the fixtures shall be attached to the main runners of the suspended ceiling at all four corners using sheet metal screws.

f. Conductors in fixture taps shall be in flexible metal conduit of 72" maximum length. A green insulated equipment grounding conductor shall be included.

g. Mount fixtures plumb and square. Keep rows in perfect line.

h. At time of project completion, fixtures and lamps shall be clean and fully operational.

SECTION 16730

EXTENSION OF EXISTING FIRE ALARM SYSTEM, ADDRESSABLE

PART 1: GENERAL

1.1 SCOPE:

a. Contractor shall extend the existing Fire Detection and Alarm System as indicated on the drawings and as specified herein.

b. Extension shall include all devices, wiring, equipment, raceways, and connections required for a complete and satisfactorily operating system, whether or not every such item is specifically shown or mentioned.

c. All initiation devices shall be analog addressable devices. The notification devices shall be installed where required to meet ADA, NFPA 72 and the North Carolina State Building Code.

d. All devices and installation methods used shall match that of the existing system.

1.2 STANDARDS AND CODES:

a. The equipment and installation shall comply with the current provisions of the following standards and codes:

1. The latest edition of the North Carolina State Building Code.

2. National Fire Protection Association Standards:

NFPA 70	National Electric Code
NFPA 72	National Fire Alarm Code
NFPA 90A	Air Conditioning Systems
NFPA 101	Life Safety Code

3. Underwriters Laboratories Inc. Standards:

(a) Underwriters Laboratories Inc. for use in fire protective signaling systems shall list the system and all components. The UL Label shall be considered as evidence of compliance with this requirement. The equipment shall be listed by UL under the following standards as applicable:

UL 864/UOJZ, APOU	Control Units for Fire Protective Signaling Systems.
UL 1076/APOU	Proprietary Burglar Alarm Units and Systems.
UL 268	Smoke Detectors for Fire Protective Signaling Systems.
UL 268A	Smoke Detectors for Duct Applications.
UL 217	Smoke Detectors Single Station.
UL 521	Heat Detectors for Fire Protective Signaling Systems.
UL 228	Door Holders for Fire Protective Signaling Systems.
UL 464	Audible Signaling Appliances.

UL 1638	Visual Signaling Appliances.
UL 38	Manually Activated Signaling Boxes.
UL 346	Water flow Indicators for Fire Protective Signaling systems.
UL 1971	Visual Signaling Appliances.
UL 1481	Power Supplies for Fire Protective Signaling Systems.

4. Americans with Disabilities Act (ADA).

1.3 CONTRACTOR QUALIFICATIONS:

a. Equipment and materials shall be provided by a factory-authorized distributor to ensure proper specification adherence, final connection, test, turnover, warranty compliance, and service. The factory-authorized distributor is required to have been in the fire alarm industry (service and installation) for a minimum of 5 years.

1.4 SUBMITTALS:

a. Shop drawings shall be submitted for each item of equipment to be furnished.

b. Submittal shall include a complete wiring and conduit diagram overlaid on a building floor plan system battery calculations and notification circuits voltage drop calculations, prepared by an authorized representative of the system manufacturer. Diagram shall indicate conductor sizes, quantities, and color coding for each conduit run, as well as required conduit sizes.

c. Evidence of listing by Underwriters' Laboratories for all proposed equipment for use as Fire Alarm equipment. (Ref.: Underwriters' Laboratories, Section UOJZ).

d. A copy of the Contractors Training Certification, issued by the manufacturer of the Fire Alarm Control Equipment, shall be provided. These qualification credentials shall not be more than two years old, to ensure up-to-date product and application knowledge on the part of the installing contractor.

e. Proof shall be furnished that the manufacturer of the Fire Alarm System Components is certified as an ISO 9001 company in each of the following disciplines: Design Engineering, Manufacturing, Technical Support, Documentation, Training, and Marketing. In lieu of such proof, the manufacturer must be able to show that the method that they employ in those disciplines is equivalent to ISO 9001 requirements.

1.5 CLOSEOUT DOCUMENTS:

a. complete set of record wiring schematics, drawn to scale; showing all device locations, wire routing and connections, etc. shall be provided prior to final inspection.

b. Warranty Statement from the manufacturer: Warranty statement will state the period of warranty for all of the products proposed for the project, and shall include the name and address of the authorized manufacturers' agent who will honor any and all warranty claims.

c. Written Certification by the Fire Alarm Contractor that no power supply or circuit in the system has an electrical load greater than 80% of its rated capacity.

d. A scaled plan of the building showing the placement of each individual item of fire alarm equipment as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway.

e. A Single Line System Block Diagram and written System Operational Overview.

f. Complete battery and voltage drop which include loads for all system components:

g. Field Connection Drawings: A complete set of drawings, one for each Fire Alarm Control Panel module which has any external (field) wiring connected to it, and one for each system detector, module or signaling appliance, shall be supplied.

h. Print-out report detailing the sensitivity of each smoke detector installed in the system. Include date on report.

1.6 SYSTEM FUNCTION:

a. In general, system function shall be as evidently intended by selection of equipment indicated herein.

b. Activation of any manual station, smoke detector, sprinkler system flow switch, or other alarm initiating device shall cause:

1. The sounding of audible signals throughout the facility.

2. The flashing of alarm indicating signal lights.

3. Indication of the alarm condition at the control panel indicating type of alarm (e.g. whether manual station, smoke detector, etc.) as well as location of initiating device.

4. Release of magnetic door holders, shut-down of air handling systems, closing of smoke dampers and other control functions as indicated or required.

5. A local sounding device in the panel shall be activated.

6. Activation (Alarm, Trouble, Supervisory) of the existing Fire Alarm System remaining for the existing building.

7. All automatic programs assigned to the alarm point shall be executed and the associated notification appliance circuits and control relays addressed and activated.

8. Other functions as noted on the drawings or as evidently intended or required.

c. All strobes shall be synchronized in common spaces.

PART 2: PRODUCTS - NOT USED

PART 3: EXECUTION

3.1 INSTALLATION:

a. Wiring shall be in accordance with manufacturer's recommendations for proper system operation.

b. Cable for monitoring and control of addressable devices shall be not less than a #18 AWG twisted shielded pair. Unless specifically noted or approved otherwise, other conductors shall be of stranded copper not smaller than #14 AWG, with THWN/THHN insulation.

c. All wiring shall be in metal raceway, unless specifically shown otherwise. Raceways shall be sized for the wiring requirements of the system proposed, with maximum conduit fill of 40%.

d. Wall-mounted system devices shall be flush mounted where construction permits. Where necessary and approved by the Architect/Engineer, surface mounting enclosures may be utilized. Contractor shall coordinate trim types.

e. Automatic detectors shall be located at least three feet from any HVAC diffuser.

f. An identification map showing all initiating devices and their address numbers shall be provided and mounted beside the main panel for quick and easy location of alarmed or troubled devices. System map shall be mounted under plexiglas.

g. All junction and connection boxes shall be painted red for easy identification.

h. Field-connected devices must be installed and wired by a Factory Trained and Authorized Fire Alarm System Sub-Contractor or a licensed electrical contractor under direct supervision of a Factory Trained and Authorized Fire Alarm System Sub-Contractor.

i. All auxiliary Power Supplies or other Fire Panels shall be located in electrical or mechanical rooms. They shall be mounted at a height between 48 to 60 inches from floor level. All such panels shall be "supervised" by the main Fire Alarm Panel.

j. All communications with remote fire alarm system monitoring shall continue to be performed by the existing fire alarm system. The new fire alarm system shall notify the existing system with all alarm, trouble and supervisory signals. In addition, the existing fire alarm system shall notify the new fire alarm system with all alarm trouble and supervisory signals.

3.2 MANUFACTURER'S RESPONSIBILITIES:

a. Final system connections shall be made by or under the direct supervision of an authorized representative of the manufacturer, who shall verify to the Architect/Engineer that the system has been left in full and proper operating condition.

b. Manufacturer's representative and a Record of Completion presented upon completion shall verify system installation and operations. The manufacturer's representative shall be responsible for an on-site demonstration of the operation of the system and initial staff training.

c. Manufacturer shall supply a 2 year warranty from date of manufactured Control System and Field Devices and appliances.

d. System shall be maintained in perfect operating condition for a period of two years following completion of the project, at no additional cost to the Owner.

e. Manufacturer shall maintain a service organization with adequate spare parts stock within 50 miles of the installation. Any defects that render the system inoperative shall be repaired within 24 hours of the owner notifying the contractor. Other defects shall be repaired within 48 hours of the owner notifying the contractor.

3.3 SPARE COMPONENTS:

a. Furnish spare components to the Owner in the following quantities, but not less than one of each type of device used on the project.

1. Fuses - 2 of each type and size
2. Manual Stations - 2% of installed quantity

3. Signal Devices - 4% of installed quantity of each type.

4. Automatic Detectors with Bases - 6% of intalled quantity of each type.

3.4 SURGE PROTECTION AND GROUNDING:

a. All equipment shall be properly grounded. Main panel shall be grounded directly to 'earth ground'. Surge protection and lightning arrestors shall be installed on the AC supply and all initiating, notification and monitoring circuits. All surge protection shall be Ditek or equivalent.

1. Ditek DTK-LVLP Series for low voltage data and signal line protection.

2. Ditek DTK-HW Series for hard wire AC protection for 120 VAC.

3.5 SYSTEM TEST AND CERTIFICATION/DEMONSTRATION:

a. The completely installed fire alarm system shall be fully tested in compliance with Testing Procedures for Signaling Systems (NFPA 72) under the supervision of a trained manufacturer's representative. The system shall be demonstrated to perform all the functions as specified.

b. The Fire Alarm System Sub-Contractor shall test:

1. Every alarm initiating device for proper response and program execution.

2. Every notification appliance for proper operation and audible/visual output.

3. All auxiliary control functions such as elevator capture, smoke door and damper release, and functional override of HVAC, ventilation, and pressurization controls.

c. The Engineer and Owner must be notified at least 10 working days prior to the scheduled testing so that he may be present for such testing.

d. After the system has been completely tested to the satisfaction of the Engineer and Owner, the Fire Alarm System Sub-Contractor shall complete the Fire Alarm System Certification of Completion form published by the NFPA.

e. The completed form signed by a principal of the Fire Alarm System Sub-Contractor and shall be delivered to the Architect/Engineer with the other system documentation required by these specifications.

3.6 INSTRUCTION OF OWNER:

a. The Fire Alarm System Sub-Contractor shall schedule and execute an instruction class for the Building owner, which details the proper operation of the installed fire alarm system. The instruction shall also cover the schedule of maintenance required by NFPA 72 and any additional maintenance recommended by the system manufacturer.

b. The instruction shall be a minimum of 4 hours in duration and presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.

c. The Fire Alarm System Sub-Contractor shall provide service and operation manuals or any other curricula that may enhance the instruction of the Building Owners or Local Municipal Fire Department in the operation and maintenance of the system. Also provide software and hardware necessary to troubleshoot and completely program the system.